CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, the need of energy production to be used for either industrial or several transportations is in great demand. The type of power generation has become the major concern because of its widespread need. For the concern of recent time needs, the suitable power generation type is one which achieves a relatively better efficiency, low in cost, and satisfied the demanding criteria.

For those needs the gas turbine system is the answer. Gas turbines are internal combustion engines that they use a rotating shaft or rotor instead of "reciprocating" in cylinders. It has the advantages of small dimensions, light weight, easy to be serviced (resulting to low maintenance cost), and most of all it can produce more power (relative to the power produced-to-weight ratio) and faster speed spin. They became practical sixty years ago; today gas turbines are one of the keystone technologies of the civilization [1].

Because of its critical role, it is understandable that innovation to a step further is needed. In a field where the major role needed and development costs both are the major concerns, it was thought to build the smallest possible gas turbine, and to explore whether the device could be made into smaller size. The microturbine is actually the scale-down of the large ordinary gas turbine system.

This is what gave birth to this project – since the advantages of gas turbines are already known compare to the others, this project deal with designing of microturbine compressor and the corresponding overall integrity analysis of the designated compressor.

1.2 Objective of Study

The objective of this study is to design a compressor shape for 100 kW microturbine output, and conduct stress analysis based on static loading condition to ascertain its structural integrity of shape under the loads experienced in its normal operation.

1.3 Scope of Study

The project also includes the dimensional design of the compressor (impeller and its shaft). The design, then, investigated by obtaining the load under various operation conditions, and then the analysis of the structure's integrity using finite element method is conducted. It is expected that the project will provide the recommendation that can help to improve the performance of compressor design base on the previous analysis.

The scope of study consists of two major parts. The first is to design the dimension of the compressor based on the given output power. The design is expected to be the most optimal dimension to that proposed output.

The second part is the analysis of the designated dimension of the compressor. This part is investigating the load acting on the compressor using computational fluid dynamic program and conducting analysis of the structural integrity using the finite element analysis program.

1.4 Outline of Report

This project is divided into six chapters. Chapter 1 presents the background of the study, which gave birth to this project. It also covers the objective of study, the scope of study and this project's outline.

Chapter 2 describes the literature review of the project. It explains the general review of the gas turbine concept. Several reference and cites' are quotes in this chapter to be the base knowledge of the design. The specific microturbine part review is described to support the specific need of the assumptions on the project.

Chapter 3 describes the step methodology to determine the properties of the design compressor to be used to the analysis. Here the flow diagrams are provided into every part design such as the shaft material design, impeller material design, compressor properties and compressor blade design, all to describe the step to obtain the data needed.

Chapter 4 discussed the dimensioning of the compressor that can be optimally suited to the designated output power. The calculations are conducted in this chapter. Assumptions on various conditions are given here together with the important base reference quotes. Then both of them will be calculated with the appropriate equations to obtain the compressor dimension and initial data's needed for further analysis.

Chapter 5 examines the data provided by previous chapter to be used on the Computational Fluid Dynamic (CFD) program, which is here will be the *Fluent* program chosen. The result data will be regarded as the loads of certain operational condition acting on the designated compressor dimension.

On chapter 6 will be introduced the using of Finite Element Analysis (FEA) program, continue by modeled design approaches provided to be examined. The data produced by the CFD program then applied to the structure analysis by using the FEA program, which uses the *Nastran* program.

On chapter 7 will asses the analysis results both by fluid dynamic aspect and finite element aspect. The safety criteria will also be provided in concern of safety for the material used. Comparison result may also be provided in order to get the optimum result of analysis. At the end the determination of material used is expected to be established.

At the end of the project, which is will be on chapter 8, will provide the highlighted conclusions and expected to have recommendation, could be provided to help to improve the performance of compressor design base on the previous analysis. This is by combining analysis from the initial design, loads acting on compressor until the structure integrity. So by this way, it is expected to have a sufficient conclusion on overall performance of the design that could be realized by making the microturbine compressor into real.